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Conference Abstract

Constraints and Avenues of Bugs Distribution Modelling in India

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Abstract

Insects, the most diverse group of organisms, are a global concern due to climate change. They are extensively distributed, playing vital ecological functions. Alterations in their spatial distribution can threaten human health and food security. India hosts over 67,000 insect species (Banerjee et al. 2025), and given the increased average temperatures and projected climate change for the region, understanding the vulnerabilities of these species is imperative. By utilising the widely adopted Species Distribution Modelling (SDM) techniques, insect distributions are mapped worldwide. Analysis of regional modelling studies can identify gaps, and alignment with global efforts to inform effective management strategies.

In this study, we conducted a systematic review using Web of Science and Scopus databases for SDM studies utilizing occurrence records from India for known insect orders (Wang et al. 2016). The research maps trend of insect SDMs and delineates key insect groups, models, predictors, occurrence data sources, and applied disciplines. A total of 118 papers were selected for final analysis. The selection method and document list is provided in Suppl. material 1. This review covers global studies and shows a greater application of SDM to insects than previously documented for India (Roy et al. 2022, Sarkar et al. 2024).

The SDM studies demonstrate a cumulative rise starting from the year 2008, with a notable increase from 2017 onwards. These studies were classified as global, regional, national, and sub-national with respect to India (Fig. 1). Spatial scope analysis showed

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that studies at the country level and below are fewest in number (17.80%), whereas majority of studies were conducted at global level (61.86%). Further analysis of the corresponding author's country revealed that, beyond national level, China is a major contributor to these studies. The literature (80.51%) was identified as most utilized data source for species data. Additionally, while global studies leveraged databases like Global Biodiversity Information Facility (GBIF) and Centre for Agriculture and Bioscience International (CABI), national studies primarily depend on field data. Most of the research were focused on five orders: Coleoptera, Diptera, Hemiptera, Hymenoptera, and Lepidoptera,
commonly known as beetles, true flies, true bugs, ants/bees, and butterflies/moths, respectively. These studies modelled distributions of 171 insect species from 10 orders and 90 genera. The majority of research centered on modelling the current distribution (58.25%) of insect invasions in agricultural and forested areas. Among the five orders, Hemiptera had the highest number of studies, in addition to the highest ratio of 1.21 genera per study. Two genera with the highest frequency of studies (7.63%) were of agricultural pests, fruit flies (Bactrocera, Diptera) and armyworms (Spodoptera, Lepidoptera). In the human health area, disease vector mosquitoes (Diptera) were the most studied, whereas in conservation context, studies on bees (Hymenoptera) were most numerous for their role as pollinators. A large proportion of studies (79.66%) used a single model, whereas 12.71% utilized ensemble methods. The most frequently used modelling algorithm was Maxent (88.98%), while use of other models remained below 12%. All studies used climatic data, followed by topographic variables in 27.12% studies.

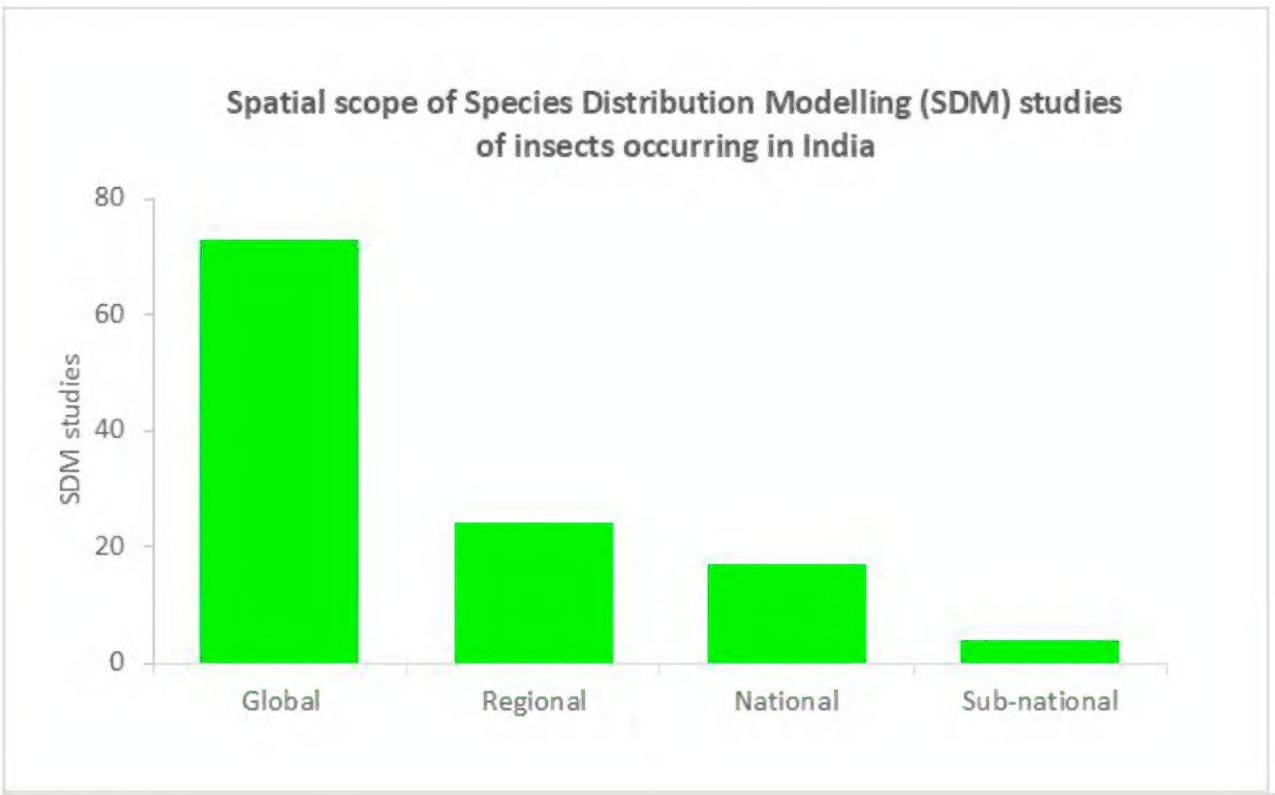

Figure 1.

Spatial scope of 118 SDM studies utilising insect occurrences from India. Mamta Sharma & PC Abhilash CC-BY 4.0

This analysis reveals that there is vast potential for further studying insect diversity through SDMs. Coverage across insect functional roles may improve socioeconomic

relevance of SDMs, particularly to address challenges of emerging vector diseases and decline of beneficial insects due to climate change. Further, utilising a diverse array of models for comparative assessment, may increase result reliability. Increased use of diverse data sources at national level can identify data inaccuracies and promote better data publishing practices in the region. The increased data application in SDMs may also encourage higher data generation for various species of local importance through collaboration of scientific experts and database managers. This study underscores the criticality of prioritizing national biodiversity data management as a measure for climate change adaptation and emphasizes the need for advanced biogeographic research to inform evidence-based actions.

Keywords

insect, species distribution model, climate change

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Conflicts of interest

The authors have declared that no competing interests exist.

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Supplementary material

Suppl. material 1: Supplimentary Bugs Distribution Modelling in India doi

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